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Piloting Socio-technical Innovation

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Abstract - Anyone familiar with the German IS research culture would expect to find numerous action researchers in Germany. However, a closer examination of the literature reveals there are relatively few if any. There are few publications claiming to report on action research and there is little if any ongoing debate on action research. This paper argues that the lack of publications is a result of a different framing of action oriented research in Germany. The purpose of this paper is to use a variant of action research, the piloting of an innovation, as a starting point for a debate on the action research methodology in Germany and to contribute to the international debate on action research. We do so in a general manner and by reflection on the research approach in the socio-technical pilot project Cuparla.

INTRODUCTION

Action Research is typically said to have three characteristics [1,2]:

1. The researcher actively intervenes in a social organization to advance both the organization's well-being and scientific knowledge.
2. The project consists of phases of interventions and of reflection for research purposes.
3. The researcher has to live up to the ethical challenges of the intervention.

Looking at this definition, anyone familiar with German IS research culture would expect to find an abundance of action researchers in Germany; but looking at the literature there are few if any. There are few publications reporting on action research and there is at present within the IS-community little ongoing debate on action research methodology (for an exception see [3]). This paper argues that the lack of publications is a result of a different framing of action oriented research in Germany. The purposes of this paper are to use a variant of action research, the piloting of an innovation, as a starting point for a debate on the action research methodology in Germany and to contribute to the international debate on action research. First we examine action research within the context of traditional German research then we reflect on this research approach using as an example the socio-technical pilot project Cuparla.

ACTION RESEARCH AND THE GERMAN RESEARCH TRADITION

The majority of the German speaking IS-community considers the active intervention into a user community a valid and valuable part of their research. "Impact on the fundamental benefit of society" and "the potential to influence organizational practice" are considered by researchers as elements of the four most important objectives of German IS-research [4]. However, the German IS community has few

researchers who call themselves „action researchers“, because they frame the intervention differently from the traditional action research approach. That is to say, the intervention is not seen as purely social, but socio-technical, sometimes even mainly technical. In a typical research project, a new innovative software is developed and introduced in the field. The application of this software then leads both to an improved software and to an intervention in a social environment. Thus this combines the traditional prototyping approach from software engineering and computer science with the action research approach from social sciences without its typical rhetorical stance. As both technology and organizations are developed simultaneously (depending on how a problem can be solved best), these research projects tend to be more complex but also have more potential for improvement and for furthering knowledge. The scientific value of these projects is twofold:

1. Measuring the effects of the software application furthers knowledge in social sciences which helps to generate or validate theories.
2. The development of the software designs and proves a technical innovation and is thus a contribution to engineering science.

The „Gestaltung“ (= design) of a social innovation is a valid contribution to the Betriebswirtschaftslehre (German business administration sciences). German business administration science has a long tradition of designing and implementing administrative systems which has its origins in work done by Schmalenbach [5] and Ulrich [6]. Thus both reference disciplines of German IS, computer science and Betriebswirtschaftslehre, traditionally regard design as a valid research contribution. Both understand the term "design" to include not only the development of a concept but also the first steps toward implementation. This design tradition had two consequences for German IS research:

1. The majority of German IS research has at least a significant design component, usually the development of a software prototype.
2. As Gestaltung is well accepted as a research contribution, there is little discussion on its methodological foundations. We do not „benefit“ from the fundamental attacks of positivistic scientists that we see in Anglo-Saxon countries. If asked, German IS researchers justify their approach with a seminal paper by Szyperski [7]. Szyperski regards the development and organizational implementation of information systems as the most complicated, but also potentially most fruitful IS research approach. A somewhat similar approach has been proposed internationally by Nunamaker and Chen [8]. They embed software development in a larger framework of field tests, experiments and explorative studies.

Pilot projects are a special version of interventionistic science. Pilot projects develop and implement technological innovations in their natural organizational and social environment. One can distinguish three levels of freedom for pilot projects. Level-one pilot projects test the acceptability of a given technological innovation, e.g. the pilot studies on video-on-demand systems. Level-two pilot projects start with a basic prototype system and endeavor to test and improve it during the pilot project. Level-three pilot projects start with an organizational problem that has the potential of being solved by a socio-technical system. First the need for support is analysed then the system is developed and implemented in the organization, and finally improvements in the system are made during the remainder of the project.

The most visible recent level-three pilot project (called „Polikom“) had the objective to electronically bridge the distance between Bonn and Berlin for the distributed German government (see e.g. [9]). Researchers are included in these pilot projects both because they are thought to be innovative and because they produce credible reports on the social and organizational effects of the intervention.

According to Witte [10] pilot projects allow for two kinds of conclusions:

1. The components of the socio-technical system and their context are the effecting variables and the realization of the innovation is regarded as the effected variable.

A pilot project can demonstrate that *if* the effecting variables are combined in an appropriate manner *then* the realization of the innovation is possible. For the trials of new media, Witte discusses the effecting variables “technology”, “media content”, “financing” and the “legal context”; the effected variables are, for example, videotext, telework or multimedia technologies. In order to make these kinds of conclusions valuable for research and practice, the researcher has to go to great lengths to describe the effecting variables in minute detail, particularly the construction principles for the combination of the initial components.

2. The realization of the innovation is the effecting variable and the effects of the technology are regarded as the effected

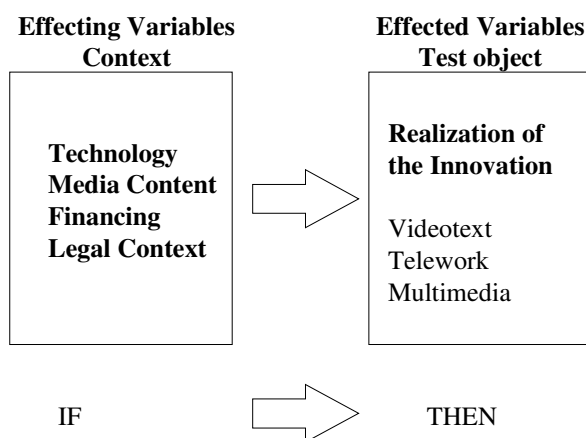


Fig. 1: New media as effected variables
(translated and abbreviated from [10, p. 422])

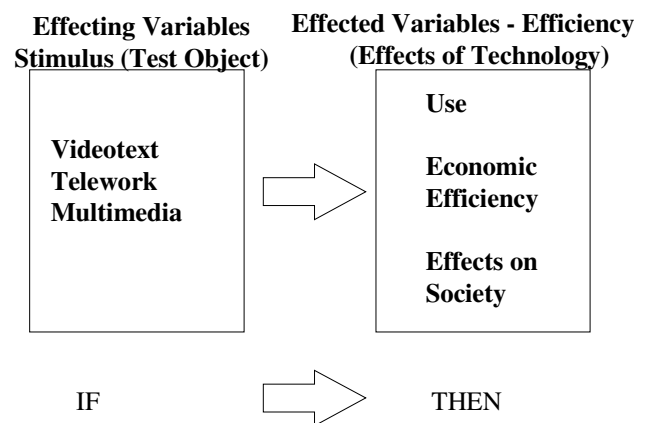


Fig. 2: New media as effecting variables
(translated and abbreviated from [10, p. 423])

variables.

The second type of conclusion points out that *if* a given socio-technical innovation (e.g. videotext, telework or multimedia) is implemented *then* the innovation leads to effects such as a specific form of usage, a specific economic efficiency and specific effects on society.

In order to make this kind of conclusion, the researcher has to undertake great efforts to measure and analyze the effects of the intervention. This can be difficult in a field setting. „Field experiments try to test hypotheses and the included propositions on the causal relationship between two or more variables by a controlled intervention in a natural social situation. In contrast to laboratory experiments with their high internal validity, the field experiment has the advantage of a high external validity, i.e. the validity of the experimentally achieved results for reality“. [10, p. 427, translated by the authors]. Pilot projects for new technologies have become common in Germany since the first cable TV trial in the beginning of the 1980s [10, p. 424]. In 1998 there were 89 pilot projects in the State of Baden-Württemberg alone [11].

Pilot projects do not only benefit research, but also offer business and society two major benefits as well: they can test the effects of innovation on a somewhat limited scale and they can serve as an example for others.

1. *Pilot projects as test of an innovation:* The only way to really assess the feasibility and effects of a socio-technical innovation is to test it in a natural environment. Parts of the technical feasibility can be tested by demonstrators or simulations, but field experiments have again and again shown that during their completion new technological demands arose and needed to be addressed [10]. The technological feasibility test was only a necessary but not a sufficient condition. Often, during actual use of a technical innovation, features different than those apparent during the prototype phase gain importance and influence acceptance. These are features such as stability, ease of use and adequacy of task support and the task itself. This is also true for other factors, such as

organizational, personal, legal and financial factors. For the diffusion of an innovation not only the feasibility needs to be proved but also economical benefits have to be demonstrated [12, p. 209]. Furthermore the public is interested in the effects on society. Particularly in a techno-skeptical country such as Germany there have been endless and often fruitless discussions on the potential effects of a technology. A pilot project performed by scientists can provide the public and business decision makers with the data they need to make an informed decision. Failing to conduct research which could provide evidence required to enhance informed decision making could be deemed unethical.

2. *Pilot projects as an example for an innovation:* If a pilot project has been a success, it can serve as a reference for other interested organizations. These cases, often also called “best practice”, are then used to illustrate not only the technical merits of an innovation but also the overall rich picture of decisions necessary for innovations. Decision makers can decide on the basis of the implemented socio-technical system, whether they want to imitate it. As the risk of a new innovation can be high, many potential users hesitate to be the first to implement. Pilot projects can therefore be an important enabler for the diffusion of socio-technical innovations. Particularly German public administration officials search for the (successful) example as a basis for their own decision on socio-technical innovation. Otherwise existing prejudices and their traditional risk-aversion can pose insurmountable obstacles to innovations.

Pilot projects often demand the consummation of an abundance of resources, due to not only the complexities of refining an innovation, but also to the technical and organizational aspects of implementation. Pilot projects can, therefore, be expensive, particularly if a new infrastructure needs to be set up and if a large number of users need to be equipped with the new technology. In addition, they can demand a lot of time, because changes in organizations and in social behavior tend to be slow and tedious. In their quest for financial resources, as well as time and patience, German researchers (particularly those at the Fraunhofer Gesellschaft for Applied Research, and to some extent those at Universities) benefit from the German institutional set-up. The German research system provides the opportunity and the incentive to build up comparatively large research institutions. German IS professors, who are usually tenured in the university system, frequently manage more than 10 fulltime post-graduate assistants and the Fraunhofer institutes (and similar institutions) often have more than 50 fulltime researchers. This makes it much easier to prepare and conduct large-scale pilot studies. Furthermore, ‘publish or perish’ is not (yet) as common as in Anglo-Saxon countries. This allows researchers to conduct long-term oriented and somewhat risky research projects. We would generally argue that the institutional set-up of a research system is as important for the choice of research approaches as general theoretical considerations on the appropriateness of methodologies. Through its engineering approach and particularly its preference for pilot projects, the German IS research system ensures its own longevity.

After these general reflections on pilot projects, we will use the pilot project Cuparla to reflect on our methodological

experiences with pilot projects in the remainder of this paper. The next sections will give an overview of the Cuparla project, its methodological approach for the socio-technical intervention and the research process involved in the project. We will then draw lessons for piloting from the Cuparla project, both from the research and the action perspective. This discussion includes the engineering challenges and the social challenges of a large pilot project. From these specific lessons we will draw some general conclusions on action research.

THE PILOT PROJECT CUPARLA

A. Objectives of Cuparla

Members of the Stuttgart city council have a large workload. In addition to their primary job (e.g. as an engineer at DaimlerChrysler) they work more than 40 hours a week in local politics and decision making [13]. While council and political party meetings are held in the city-hall, members do not have an office there. They prepare meetings and read and file official documents at home. In a city with more than 500.000 inhabitants, they receive quite a few documents. Council members feel that they could be better informed by the administration and better use could be made of their time. As there was no previous work on the collaboration support of city councils, we launched the Cuparla project to improve the information access and collaboration of council members.

A detailed analysis of council work revealed the following characteristics :

- Since council members are very mobile they need anytime any-place support.
- Council members collaborate and behave differently in different contexts. While they are informal and open in their party they are more controlled and formal in official council meetings.
- The closer one looks at council work, the less structure there is. Every council member has the right of initiative and can inform and involve other members and members of the administration in any order.
- Council members rarely are power computer users. Computer support for them has to be very easy to use.

The objective of the Cuparla Project was

- to make the work of local councils more efficient and flexible,
- to improve information access for council members,
- to reduce communication barriers between council and administration and within the council.

The Cuparla objectives made it necessary to analyze the need for support, to develop a suitable software, to implement it in the council and the administration, and to evaluate the

* The project partners were: Hohenheim University, Dept. of Information Systems (Coordinator), Datenzentrale Baden-Württemberg and ITM Informations- und Technologie Management GmbH. The project was funded by DeTeBerkom GmbH, a 100% subsidiary of German Telekom as part of its R&D program.

effects. Cuparla thus is a level-three pilot project. Cuparla was launched at the end of 1995. In the fall of 1997, almost all members of the city council were using the system. After the end of the project in the Spring of 1998, the city of Stuttgart decided to continue using and funding Cuparla. At the time of this writing (Spring 2000), Cuparla has become the usual way of doing city council work in Stuttgart. After the most recent city council election, the new members of the city council all received extensive training with the Cuparla systems as their initiation into the city council work. Further information on the Cuparla project can be found in [13] or [13b] in this volume.

B. The Methodological Approach for Socio-Technical Interventions

A large level three pilot project requires a methodological foundation that spans analysis, design, intervention and

evaluation. As we were not aware of any methodology that appeared suitable to concurrently design software and intervene in an organization in a large group environment, we initiated a German Telekom methodology project from Summer 1994 to Summer 1996 [14] called BTÖV. One result of BTÖV was our own Needs Driven Approach - NDA [15]. NDA analyzes group tasks, cooperation processes, group interaction, social cooperation structure, cooperation tools, workrooms, adoption of artifacts and memory aspects of collaboration. The results of the analysis are used as a basis for the design of socio-technical collaboration systems. The successful application of the NDA in other projects convinced us to use it as a basis for the Cuparla project. We therefore embedded the NDA in a larger cyclic framework.

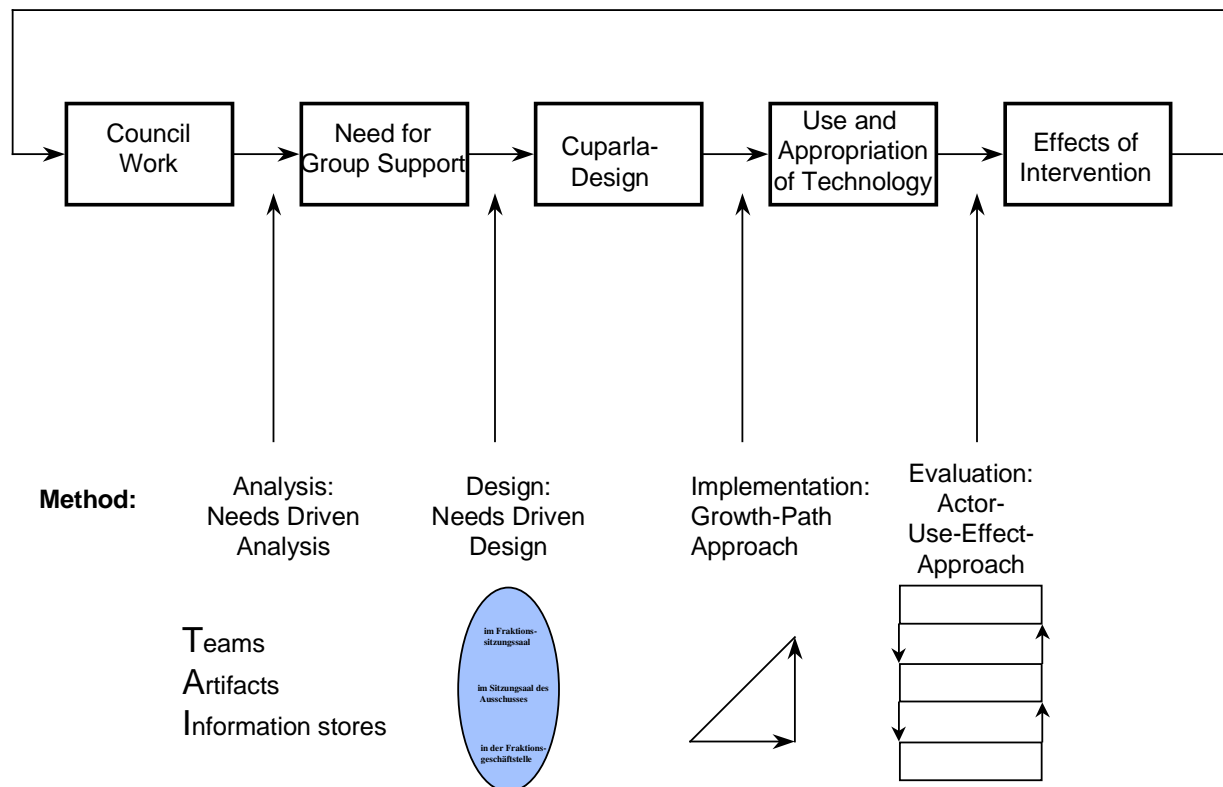


Fig. 3: The framework of the Cuparla project

The research project started with a detailed analysis of council work using the Needs Driven Analysis. As a result of this analysis we were able to specify a specific need for group support. This need served as the basis for the Cuparla design and the development of a new kind of groupware (for a description of the Cuparla Software see e.g. [16]). This software was then implemented by the Cuparla Team and used and

appropriated by the city council. After several months of usage, the effects of the intervention were measured. The project went through these phases twice: during the first cycle 11 city council members tested the software; the results of the evaluation were then fed into a second analysis, design, implementation and evaluation phase. By the end of the second cycle, the software was used by 55 of 56 active city council

members. Towards the end of the second cycle, we also introduced the Cuparla System in the small city of Kornwestheim in order to determine how scalable the result were. Here we went through the cycle only once.

As Cuparla went through the whole cycle from the development of the innovation to the measuring of its effects, it can be regarded both as an effected variable and as an effecting variable. We will analyze it both ways in the next two sections.

C. Cuparla as effected variable

Looking at Cuparla as an effected variable means that one is interested in the conditions that lead to the success of the socio-technical intervention. Specifically these conditions include

- the size and location of the community and the council
- the legal context of council work (particularly the strict German data protection laws and laws regulating council work),
- the technological context of council work, e.g. the previous computerization of administrative and council work,
- the material of council work, e.g. the documents and their media,
- the educational background of the council members, particularly their previous know-how of computers,
- the state of the art of groupware research and tools,
- the organizational context of council work, particularly typical processes, events, rules and resources,
- the incentive structure of council work,
- the demand on the council member's intellectual resources and their time
- the collaborative culture inside the council, particularly between and inside the factions.
- the daily and weekly distribution of council work (e.g. how much work has to be done during normal office hours),
- the geographical and physical setting of council work,
- the appropriation of the tools and
- the capability of the implementers (see next section).

As these factors are complex and interwoven, it is not feasible to measure all of these factors in isolation. We rather strove to paint a rich picture, to deduce candidates for key influences and then measure or estimate them as best as possible. The key to the successful analysis of the effecting variables were regular periods of reflection. About twice a year,

	Cost	Time	Quality	Flexibility	Human Situation
Individual					
Group					
Business Process					
Organization					

Fig. 5: The Cuparla framework to evaluate efficiency

one has hypotheses on what circumstances can lead to an innovation like Cuparla. As there is up to date no other German city using a system like Cuparla, it has not been possible to validate these hypothesis. We were however able to check the consistency of the relationship between some factors by conducting a survey with about 1300 German city council members outside Stuttgart. An easy example: there is a strong relationship between the size of a city and the time council work requires. There also appears to be a close relationship between the council work time and the need for support. From this we can deduce that „ceteris paribus“ the larger a city is, the more probable is the success of an innovation like Cuparla.

D. Cuparla as effecting variable

Looking at Cuparla as an effecting variable means that one is interested in the consequences of the socio-technical intervention, particularly in its influence on efficiency. Specifically this meant that one first had to establish a baseline before the intervention to be used as a comparison against the final results. Furthermore, one needs to measure the effects of the intervention and isolate factors that explain the observed behavior and effects. If the implementation is to benefit from the results of the evaluation, the evaluation should accompany the project and should not just be performed at the end of the project [12]. We therefore developed a three-layered framework for the Cuparla evaluation.

The lowest evaluation level evaluates the observable effects on council work and thus answers Witte's [10] question on the effects of Cuparla on efficiency. We extended Reichwald's [12] framework to evaluate efficiency to come up with

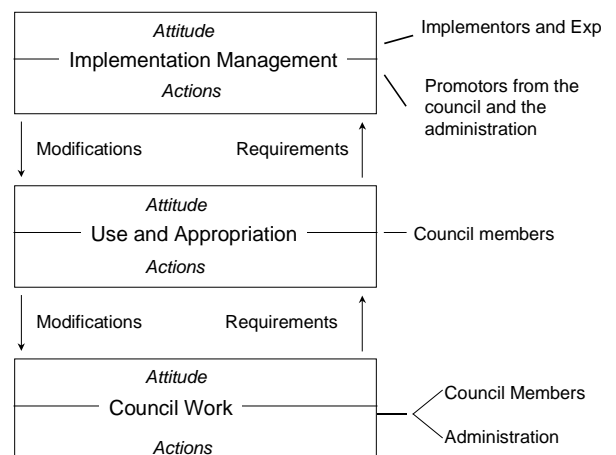


Fig. 4: Levels and actors of implementation

a four by five factor matrix.

Effects are measured on the level of the individual, of the group (e.g. council factions), the business processes and the whole administration. For each level, not only cost factors were measured, but also time (e.g. time to prepare a proposal), quality, flexibility and the human situation (e.g. is it attractive to become a council member). Each field in the matrix is itself covered by a set of criteria. The data for the criteria was collected by a mixture of quantitative instruments (e.g. questionnaires and time protocols) and qualitative instruments (e.g. observations, workshops and interviews). We collected data both on the activities and on the attitude of the council members and selected members of the administration.

We were, however, not only interested in *what* the results of the interventions were, but also, *why* they occurred. Following the adaptive structuration theory [17], we regarded the observed results as an effect of the use and appropriation of the groupware. We therefore measured and analyzed all software usage by the council members and observed the usage behavior. We assumed that the observed appropriation styles was shaped by the requirements of council work (see Fig. 4).

The observed appropriation again is in part determined by the actions of the implementers and experts, i.e. the Cuparla project team and interested promoters inside the administration and council. Since the implementers are said to have a decisive influence on the success of the implementation [18, 19, 20], we were particularly interested in what specific measure lead to what effects of usage. For example, we experimented with different kinds of training [21] and observed its effects on the appropriation and usage of the groupware. The empirical basis for the cause-effect relationship between implementation activities and software use and appropriation were workshops, questionnaires, notes on the activities of the implementers and the server protocols of software usage. On the other hand, the resulting usage of the software was an important input to guide the further implementation process.

LESSONS ON PILOTING

Cuparla taught us some lessons that go beyond the characteristics and advice often discussed in action research literature (for an overview see [22]). Purely for analytical reasons, we will distinguish between “action lessons” that made the intervention work and “research lessons” that contributed to scientific knowledge. We will furthermore distinguish between the social science domain and the engineering domain.

E. Social Action Lessons

The literature on action research sufficiently describes the ethical challenges to the social scientist moving into organizations (see e.g. [22]). Equally important are management challenges during the project. Our most important lesson is from management:

Lesson: The weakest indispensable element of a sociotechnical system determines the overall success of the intervention

Organizational interventions simultaneously concern many people and many aspects of their work. Any failure of one of the factors mentioned in chapter 3.3. can lead to the failure of the pilot project. Therefore most of the time spent in a pilot project does not deal with the scientifically most “interesting” areas for the research community, but rather with the daily

necessities to allow the intervention to become a success (within ethical limits). While that aspect is often discussed in the management and leadership literature, it is hardly mentioned in action research discussions.

F. Social Research Lessons

Lesson 1: Traditional research methods can be fruitfully embedded in action research projects.

Action research need not be seen as an alternative for “scientific” methods, but rather as a framework for a research project that relaxes some pre-conditions of some social science research methods (most important the assumed independence of the observer from the observations). We successfully applied a whole set of social science data collection approaches. As we were beneficial to the research subjects (the council members) their willingness to participate in data collection efforts was much higher than if we had just asked them as outsiders with no promise to improve their work situation. The higher data quality due to the increased efforts from the council members compensates for the perceived loss of quality due to the involvement of the researchers. Action research offers better opportunities for data collection than many other research approaches. The researcher should use this opportunity to apply the most rigorous data collection and research methodologies possible within the context of the research project.

Lesson 2: Regular descriptive and analytical writing is the single most important tool to enforce and support the reflection phases of action research.

The German poet and philosopher Kleist [23] wrote a famous piece about “the ongoing formation of ideas during a conversation”. For the level of abstraction research requires we would argue that the “ongoing formation of ideas during writing” can greatly enhance the quality of the results of an action research project. Writing should not just report data collection or description, but should explicitly include analytical writing and sensemaking. The documented assumptions and analysis can later serve as a baseline to analyze the learning of the research team. The explicit demand for written analysis during the project furthermore enforces sufficient reflection periods.

Lesson 3: An action research project should be accompanied by its own methodology track, that develops and refines the research approach on a medium level of abstraction.

There has been debate if action research begins without utilizing a particular research methodology or if the research methodology should be exactly defined before the start of the project [24]. The first approach is seen as unscientific and can lead to incoherent, incomplete and far too much data. The latter approach does not take the dynamic nature of an action research project into account. We would therefore argue that it is beneficial to develop a general framework and methodology before starting the project, but to refine and enhance it during the course of the research project. This approach assures a research focus and is sufficiently open to live up to the dynamics of an implementation project. A suitable way to implement this refinement of methodology is a separate methodology track as part of the research project. The objective of this project is to develop an appropriate methodology

on a medium level of abstraction. This methodology can then serve as a reference model for similar research projects.

Lesson 4: Most action research results are on a medium level of abstraction

Qualitative research typically draws its legitimacy from the opportunity to reach a deeper and richer understanding of a problem. In pilot projects, this deeper understanding is not reached by understanding one variable to great depths, but rather in the deeper understanding of the relationships between many interdependent variables. This leads to a “rich picture” as a result of the project. Typically this rich picture describes and explains the domain on a medium level of abstraction¹.

G. Engineering Action Lessons

The Engineering lessons focus on pilot projects because the implementation of technical artifacts is not typical for classical action research.

Lesson 1: Pilot projects require prototypes of a far better quality than demonstration prototypes.

A demonstration prototype (demonstrator) only has to make obvious new functionality in a meaningful test context. A pilot prototype has to be usable in a real environment. This requires a far better quality and a far enhanced and even comprehensive functionality. In Cuparla, we spent only a few weeks to develop a first software prototype that already contained 90% of the functionality of the final system. However it took several months to fine-tune it to make it really useful for the council members. We would therefore recommend to include professional software developers (and not only researchers!) in the action research team, because they are capable of and interested in performing the fine-tuning.

From a researcher's point of view, the efforts to implement a pilot prototype can only be justified by an equally interesting research field. Most of the time this justification then stems from social sciences and from the expected results in a domain perspective.

Lesson 2: The pilot project proves the feasibility of the innovation, but the pilot prototype is not a product.

The pilot project proves the feasibility of the innovation, but the underlying software system is typically not scalable. One can therefore not expect to be able to immediately market the innovation after it has proved its feasibility in the pilot project.

H. Engineering Research Lessons

Lesson 1: It is far easier and more rewarding to strive for integrating innovations than to focus on functional innovations during the pilot project.

While large functional innovations may be a suitable starting point for a pilot project, they become more problematic later on. Functional innovations in IT tend to be deep and narrow; the user already applying technology typically needs broad and shallow support. For example, during a recent

German pilot project, the research team spent a large proportion of their time on developing sophisticated awareness features for the groupware to be used. While these features were true technological innovations, the user would have most likely preferred a less advanced environment that provides access to their day-to-day data. Innovations developed during the course of the pilot project should be based on the need of integration appearing while using the application. For example, the major technological innovation of Cuparla was the development of a user interface that integrated all needed software functionality in an extremely easy to understand and easy to use manner.

Lesson 2: Socio-technical frameworks can be beneficial for engineering

Although IS research strives to bridge information technology and organization, most research papers still incorporate the schism between these two “worlds”. They either regard the technology as a given and analyze the changes happening in an organization or they simply deduce requirements from organizations (regarding them as given) and use these requirements to design a suitable system. However, in reality both can be changed at the same time and combined changes can solve problems that any change on only one side (technology or organization) cannot resolve. We have found great value in using an integrated socio-technical systems approach as a basis for our analysis and design (for a general discussion on this approach see [25,26] and the German approach on work sciences [27]). This approach allows us to use the same analytical results as an input for software design and social science research.

CONCLUSIONS ON ACTION RESEARCH

Action research is seen by many as a fashionable way to describe consultancy and a good excuse to move in the field without second thoughts. On a more serious level, this research approach provides the background to link action and research. In the German IS-research tradition, however, the combination of understanding and engineering is seen as a key concept and the role of innovation is seen as one of the elements of an academic profile. In this light, action research and piloting fall on established ground, which combines economic research with an artifact generating engineering tradition. It is probably due to this understanding of the discipline as a social research AND engineering perspective, that the link between action and research is not only grudgingly accepted, but also seen as the highest form of linkage thus furthering the contribution of science to society.

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¹ As a corollary, action research is hardly adequate to understand in depth one singled out variable of social situation

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